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Gestational Diabetes Mellitus After Delivery

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1. Introduction

Gestational Diabetes Mellitus (GDM) bring repercussions not only during pregnancy and delivery, but also in the future, with implications for Public Health. Nonetheless, after delivery, there is a tendency of the health team and medical institutions to relax the care given to women with GDM, probably due to the fact that their blood glucose values usually return rapidly to their normal level, wasting in this way the opportunity of preserving the health status of these relatively young group of women with a high risk of cardiovascular events, greatly due to the subsequent development of type 2 diabetes (Bentley-Lewis, 2009; Shah et al., 2008). In recent years an increase in the prevalence of GDM in different populations and ethnic groups has been observed (Dabelea et al., 2005; Hunt & Schuller, 2007). Being GDM, very frequently, a diabetes precursor, a large number of fertile women will be increasingly subjected to a higher risk of developing it in a variable time, generally during middle age. This implies a long period of potential risk for chronic micro and macroangiophatic complications, with implied high social and economical costs.

Women with GDM constitute an excellent target for applying diabetes preventive measures and its comorbidities. In this sense, a continuous and prolonged post-partum follow-up is recommended with two main objectives: to implement non-pharmacological and pharmacological preventive measures, whose efficiency has been shown in some studies (Buchanan et al., 2002; Ratner et al., 2008), and also to carry out early detection of diabetes and other cardiovascular risk factors by guidelines that unfortunately, vary from one organization to another (Asociación Latinoamericana de Diabetes (ALAD), 2008: Metzger et al., 2007: National Institute for Health and Clinical Excellence (NICE), 2008), partly explaining low compliance rates and short duration of follow-ups, even in developed countries (Blatt et al., 2011; Dinh et al., 2003; Ferrara et al., 2009; Kim et al., 2007a). Moreover, maternal breastfeeding stimulus and the most adequate contraceptive method are included (Kim, 2009, 2010; Kitzmiller et al., 2007). More recently, the association between GDM with periodontal disease has been demonstrated, therefore it was considered pertinent to include oral health measures (Friedlander et al., 2007; Novak et al., 2006).

During pregnancy, women with GDM require education under the premise that glucose intolerance is not always transitory, but that at any time after delivery it can become permanent, in order to increase awareness of the importance of postpartum follow-up, during which educational strategies aimed at correcting knowledge deficits on healthy life-styles are studied in-depth (Rivas et al., 2010a); moreover, to overcome difficulties found in substituting inadequate habits in practice (Smith et al., 2005; Stage et al., 2004). To do so, it

seems essential to incorporate profound changes in the quality of life of the population that favor individual life-style changes. However, for a postpartum follow-up program to be successful, it is also important to amend existing weaknesses regarding knowledge and motivation of the interdisciplinary team responsible for health care in this area (Almario et al., 2008; Clark et al., 2003), and also, to provide health care services with easy access for all women with previous GDM (Kim et al., 2007a).
This chapter will expound on focusing the future risks of women with GDM, as well as the basic aspects regarding early detection and prevention of diabetes and other cardiovascular risk factors.

2. Maternal risks

Maternal GDM repercussions in the future include an increased risk of developing GDM in subsequent pregnancies (Moses, 1997a), type 2 diabetes (Kim et al., 2002) and other cardiovascular risk factors such as obesity (Yun et al., 2007), dyslipidemia (Meyer-Seifer, 1996) and hypertension (Gonçalves et al., 2005), which show up isolated or grouped in the Metabolic Syndrome (Madarász et al., 2008). Generally, they are accompanied by some degree of vascular, fibrinolytic and inflammatory dysfunction (Farhan et al., 2006¸ Heitritter, 2005). Furthermore, the risk of other clinical conditions like polycystic ovary (PCO) (Kousta et al., 2000), periodontal disease (Xiong et al., 2006) and depression (34 Kozhimannil et al., 2009) is increased (Table 1).

- GDM in subsequent pregnancies
- Type 1 diabetes
- Type 2 diabetes
- Metabolic Syndrome
- Vascular abnormalities
- Cardiovascular Disease
- Polycystic ovaries
- Periodontal Disease
- Depression

Table 1. Maternal Risks in women with Previous GDM

2.1 GDM in subsequent pregnancies

GDM recurrence occurs due to an abnormal glucose tolerance state that aggravates primarily due to physiological demands and hormonal changes of pregnancy itself, but may also show the presence of type 2 diabetes, that was not diagnosed between pregnancies, since a postpartum diabetes screening was not carried out.
GDM recurrence rates in subsequent pregnancies show contradictory results, varying in different studies according to the population studied, GDM diagnostic criteria used, diabetes postpartum screenings and the exclusion or not of the preexisting diabetes proportion. In a review, it was found that they ranged from 30 and 84%, being White women rates <40% and in other ethnic groups that include African-American, Latin-American an Asian women >50%, constituting ethnic group different from Caucasian, the most consistent predictor of GDM recurrence (Kim et al., 2007b).Other associations have been reported with GDM recurrence such as fat intake (Moses et al., 1997b), pre-pregnancy

maternal weight (Macneill et al., 2001) and the presence of impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) in two-month postpartum screenings (Kwak et al., 2008).
GDM risk in a second pregnancy has been found nearly ten-folds higher among women with previous GDM than in women without this family history, 41.3% and 4.2%, respectively. The risk increases with the number of previous GDM episodes and thus, with the third pregnancy, GDM recurrence was more marked when GDM had been diagnosed during the two previous pregnancies (Getahun et al., 2010).
A new GDM pregnancy is not associated itself to a risk increase of type 2 diabetes in women with GDM history (Russel et al., 2008). Nonetheless, the absence of recurrent GDM in a subsequent pregnancy may show a decrease in the risk of developing type 2 diabetes (Retnakaran et al., 2011).

2.2 Diabetes

There is strong evidence proving that women with GDM show a high risk of developing diabetes through their lives (Damm et al., 2003). Even though the highest frequency corresponds to type 2 diabetes, type 1 diabetes may also occur, whose proportion will vary depending on the population studied (Järvelä et al., 2006).

2.2.1 Type 1 diabetes

For many decades GDM has been acknowledged as a heterogeneous alteration, where autoimmunity against beta cells constitutes the pathogenic basis in a small group of patients, who show a higher risk of developing type 1 diabetes during pregnancy or after delivery (Mauricio et al., 1996).
In women with GDM, the determination of different specific antibodies against pancreatic beta cells, like antibodies to islet cells (ICA), glutamic acid decarboxilase antibodies (GADA), tyrosine phosphatase tyrosine (IA-2A), and most recently, GAD 65, proven pre-clinical markers of type 1 diabetes (Mitchell et al., 2000; Murgia et al., 2008), has allowed to know that autoimmune GDM corresponds to 10% of GDM cases in Caucasian women and contributes to a peculiar and complex pre-diabetic state, with a high risk for progressing to type 1 diabetes and to a latent autoimmune diabetes of adulthood (LADA) (de Leiva et al., 2007; Lapolla et al., 2009). The risk increases with the number of antibodies present (Füchtenbusch et al., 1997), and is higher during the first postpartum years (Nilsson et al., 2007). In studies carried out on women with GDM that show positive antibodies, it was found that they were younger, showed lower body mass index (BMI), less proportion of family members with diabetes, less abdominal circumference, and lower levels of plasmatic insulin than in those women without antibodies. Moreover, they had gained less weight during pregnancy and had required insulin treatment in a higher proportion (Bo et al., 2003). Non-Caucasian women with GDM have been less studied looking for autoimmune markers, being found in some cases, similar GADA incidence than in Caucasian women (Kousta et al., 2001), while in other studies, lower incidences have been obtained, but resulting likewise, the presence of antibodies against beta cells, an indicator of future type 1 diabetes, even at early stages after delivery (Yu et al, 2009).
The presence of antibodies in women with GDM shows immune-mediated pancreas destruction that causes a deficit in insulin secretion and development of type 1 diabetes. Therefore, the importance of making a type 1 diabetes diagnose as soon as possible, to apply therapeutic measures that allow preserving the endogenous insulin secretion and to reach

an adequate metabolic control that lowers the risk of poor pregnancy results (Wucher et al., 2011) and of micro-vascular maternal complications in the future. Thus, in high risk populations of women with GDM, type 1 diabetes screenings must be carried out, looking for antibodies against beta cells.

2.2.2 Type 2 diabetes

Numerous epidemiological data suggest an association between GDM and type 2 diabetes, showing correspondence in both prevalences in a given population. These two disorders share metabolic aspects, risk factors and genetic susceptibility (Ben-Haroush et al., 2004).

Physiopathological changes that occur in GDM, insulin resistance and the relative insulin deficiency due to the pancreatic beta cells deterioration, are similar to processes that occur in other pre-diabetic states of type 2 diabetes (Harlev & Wiznitzer, 2010) and they persist after pregnancy (Kousta et al., 2003). GDM and type 2 diabetes also have in common risk factors like BMI increase, family history of diabetes, increased age, Asian and African ethnic origin (Kim et al., 2002). Likewise, evidence has been gathered regarding that GDM susceptibility, as well as type 2 diabetes, has a genetic component where pregnancy could act as an environmental stressor that catalyses progression to a diabetic state in women with genetic predisposition. It is possible that both conditions are multigenic diseases in whose etiology interact variations of multiple genes with environmental factors, but no definite conclusions can yet be established, since the study on GDM genetics is on its initial stages and also because most researches have been carried out on a small group of White ethnic women (Robitaille & Grant, 2008), finding in some of them, that alleles associated to an increase of developing type 2 diabetes, are elevated in women with previous GDM (Lauenborg et al., 2009).

Cumulative incidence of type 2 diabetes varies widely in different reports, with a range of 2.6 to 70% in studies that examined women between 6 weeks postpartum to 28 years postpartum (Kim et al., 2002. During the first months, glucose tolerance abnormalities in women with previous GDM were already found, showing diabetes prevalence rates < 10% in White ethnic women (Pallardo et al., 1999; Feig et al., 2008) and ~10%, or higher in other ethnic groups (Kjos et al., 1990; Lin et al., 2005; Rivas et al., 2007). These rates most probably include women with type 2 diabetes, whose diagnosis had been unnoticed before pregnancy, being impossible to exclude them, due to the GDM definition used worldwide.

Progress to diabetes is strong during the first years after delivery, with an annual rate of 5-10%, reaching ~50% in five years, followed by a slower progression, and appearing a plateau after ten years (Kim et al., 2002; Wollitzer & Jovanovic, 2007). However, more recent studies show that postpartum risk of diabetes in women with DGM increases linearly through the follow-up period, without indication of decrease after five years or plateau evidence of the incidence at ten years postpartum (Feig et al., 2008; Chodick et al.,2010).

It has been estimated that in women with GDM, the risk of developing type 2 diabetes along their lives is almost eight-fold higher than in those women who have not developed it (Chodick et al., 2010; Bellamy et al., 2009). In the well-known study Diabetes Prevention Program (DPP), women with GDM history showed a 74% increased hazard for developing diabetes than women without this history (17.1%/year compared to 9.8%/year, respectively) (Ratner et al., 2008) and, in Australia, it was found that 20-30% of women with type 2 diabetes refer previous GDM (Cheung & Byth, 2003).

Several maternal risk factors have been associated to the conversion rate to diabetes, resulting highly predictive at short and long-term the oral glucose tolerance test (OGTT)

values during pregnancy, mainly, fasting plasma glucose (FPG) (Kim et al., 2002; Golden et al., 2009) and in lower proportion, 2-hour glucose values (Golden et al., 2009; Åberg et al., 2002), area under OGTT curve (Golden et al., 2009; Weijers et al., 2006) and the number of OGTT abnormal values (Chodick et al., 2010). It has also been found that insulin therapy during pregnancy predicts future maternal diabetes (Chodick et al., 2010; Catalano et al., 1991) and it is known that weight gain before, during and after pregnancy increases and accelerates the development of type 2 diabetes in women with previous GDM (Metzger et al,. 1993; Baptiste-Roberts et al., 2009; Xiang et al 2010).

Other risk factors of type 2 diabetes in women with DGM have been reported, among them, age, non-Caucasian ethnicity, early GDM onset (Sinha et al,. 2003), length of postpartum period, deterioration of beta cell function and use of progestin-only contraception (Xiang et al 2010, Xiang et al 2006a). A series of modifiable factors like low physical activity, low fruit and vegetable consumption, tobacco habits, low educational instruction, and low family income have also been found associated to the risk of type 2 diabetes in women with GDM history (Yun S et al., 2007). There is less knowledge on other risk factors of diabetes described in recent years in women with GDM, such as alteration of some inflammatory and fibrinolytic dysfunction markers, among them adiponectin decrease (Retnakaran et al. 2010), increase in C-reactive protein (CRP) (Di Benedetto et al., 2005), homocysteine (Cho et al., 2005) and plasminogen activator inhibitor type 1 (PAI-1) (Morimitsu et al., 2007), among others.

2.3 Metabolic syndrome and its components

GDM is a marker for future development of type 2 diabetes and Metabolic Syndrome in the mother, currently acknowledging pregnancy as a window that reveals future metabolic and cardiovascular risks for the mother (Sattar & Greer 2002).

Glucose tolerance abnormalities in postpartum have been associated to other components of the Metabolic Syndrome. General obesity (Vohr & Boney, 2008), visceral obesity (Albareda et al,. 2005) and increases in body fat content, particularly visceral fat (Lim et al., 2007), are more frequent in women with GDM history compared to those in control groups. Also there is a higher risk of high blood pressure (Gonçalves et al., 2005; Wender-Ozegowska et al., 2007) and impairment of lipid profile like high triglycerides and LDL-cholesterol values and low HDL-cholesterol values, even though some results are not always consistent (Wender-Ozegowska et al., 2007; Meyers-Seifer & Vohr, 1996; Rivas et al., 2010b). Frequently, varying abnormalities are found both in insulin sensitivity as well as in the secretion function of pancreatic beta cells (Tura et al., 2008).

The prevalence of the Metabolic Syndrome, regardless of the diagnostic criteria used, is three-fold higher in women with previous GDM than in women without this history and increases seven-fold in obese women (Lauenborg et al., 2005). Pre-pregnancy obesity, OGTT fasting plasma glucose during index pregnancy and postpartum weight gain are predictors of developing Metabolic Syndrome (Akinci et al., 2010).

2.4 Vascular abnormalities

As in other high risk type 2 diabetes groups, in women with previous GDM, apart from abdominal obesity and insulin resistance, vascular abnormalities including impaired vascular reactivity, increased levels of some markers of endothelial activation, fibrinolysis/coagulation and low grade subclinical inflammation have been found (Caballero, 2005).

Among the reported vascular abnormalities are increase of peripheral vascular resistance (Heitritter et al., 2005) and impaired endothelium-dependent vasodilation, assessed at the brachial artery by high resolution ultrasound (Anastasiou etal., 1998), but this finding was not found in another study (Hannemann et al., 2002). On the other hand, serum adiponectin levels, an adipokine with known vascular effects, have been found to be lower in women with GDM during pregnancy and postpartum (Heitritter et al., 2005; Vitoratos et al., 2008a; Costacou et al., 2008). On the contrary, PAI-1 has been found elevated, considered as an expression of fibrinolytic dysfunction (Farhan et al., 2006), and of markers of low-grade sub-clinical inflammation, Interleukin-1beta (IL-1β) has also been found elevated (Vitoratos et al., 2008b), whereas CRP shows contradictory results, since in some studies higher values have been obtained in women with previous GDM than in women with normoglycemic pregnancies (Heitritter et al., 2005; Di Cianni et al., 2007), no differences have been shown in other studies (Thomann et al., 2008) and in some, it is only significant the increase of CRP when diabetes has already been developed (Kim et al., 2008).

2.5 Cardiovascular disease (CVD)

As it has been described previously, women with previous GDM show in higher proportion, compared to women in control groups, numerous cardiovascular risk factors such as abdominal obesity, insulin resistance, abnormal glucose tolerance, dyslipidemia, high blood pressure values, Metabolic Syndrome, impairments of endothelial dysfunction and inflammation markers. For this reason, it has been proposed that these women have higher long-term probabilities of developing CVD (Bentley-Lewis, 2009), showing in an incidence research review that GDM history increases the risk of CVD about 1.7 folds (Verier-Mine, 2010). This topic is of vital importance since CVD, and particularly, coronary artery disease, constitute one of the main causes of mortality and disability in different countries, thus its prevention and early identification in this group of young women may contribute to improve health indicators.

2.6 Polycystic ovaries

The prevalence of PCO has been found elevated in women with previous GDM, showing that both pathologies have common associations like obesity and insulin resistance (Kousta et al., 2000; Koivunen et al., 2001).

2.7 Periodontal disease

Women with GDM have shown higher frequency and severity of periodontal disease during pregnancy and postpartum than women without GDM, after controlling for age, income, smoking, dental calculus (Novak et al., 2006). The prevalence of periodontal disease in women with previous GDM is lower than in non-pregnant women with type 1 and 2 diabetes, but higher than in non-diabetic women and without GDM family history (Xiong et al., 2006). A higher risk of dental caries also seems to exist (Friedlander et al., 2007).

2.8 Stress, anxiety and depression

Pregnancy generally represents an increase in stress and anxiety in all women, therefore, when GDM develops, considered as a high risk pregnancy demanding comprehensive treatment measures and monitoring of metabolic control, stress levels may increase even more (York et al., 1996). However, there are very few studies on this topic. On the other

hand, an association between diabetes during pregnancy and prenatal depression in low-income women has been found (Kozhimannil et al., 2009), showing the importance of psycho-social aspects.

3. Detection and prevention of diabetes and other cardiovascular risk factors

Care for women with GDM is extended after delivery in order to assess at an early stage their new metabolic status, and more importantly, to take individual and collective measures that contribute to prevent or at least, retard the progression to diabetes and other cardiovascular risk factors. Thus, it is necessary that health services provide postpartum follow-up programs and motivate women with GDM to attend the activities programmed. Moreover, it is fundamental that the environment surrounding such women promotes life-style changes that not only favor them, but also their family and the rest of the population.

3.1 Postpartum follow-up of women with GDM

For many years the importance of postpartum follow-up of women with GDM has been emphasized (Beischer et al., 1997). More recent findings suggest that it should be extended to women with any abnormal glucose homeostasis level during pregnancy (Retnakaran et al., 2008). Such a follow-up includes the aspects shown in Table 2.

- Diabetes screening
- Detection of cardiovascular risk factors
- Education
- Incentive and facilities for breastfeeding
- Appropriate family planning and contraception
- Oral health measures
- Life-style changes
- **Pharmacologic intervention**

Table 2. Postpartum Follow-up of women with GDM

3.1.1 Diabetes screening

During the immediate post-partum period of patients with GDM, glucose tests are run to detect those few cases where hyperglycemia persists, which mainly correspond to women whose type 2 diabetes had not been detected before pregnancy. The diabetes diagnose is confirmed if FPG is $\geq$ 126 mg/dl (7.0 mmol/l) or if hyperglycemia symptoms and a random plasma glucose $\geq$ 200 mg/dl (11.1 mmol/l) are present (American Diabetes Association (ADA), 2011).

All those women not diagnosed with diabetes are programmed for a diabetes screening between weeks six and twelve of postpartum, due to a high incidence of glucose tolerance abnormalities already detected at that time and also because these results allow identifying women with high risks of developing diabetes during the next fifteen years (Kjos et al., 1995). If diabetes screening is not possible at this time, it must be emphasized in the following weeks. Diabetes screening is carried out with a 75g- 2h- OGTT, of higher sensitivity and less expensive per diabetes case detected than FPG (Ferrara et al., 2009; Kim

et al., 2007b). If the results are not compatible with diabetes diagnose, whether they are normal or indicators of IGT, or IFG, the test is repeated the following year and then, annually or every three years, according to the different international scientific associations since regarding periodicity of screening, no current criteria uniformity exists (Metzger et al., 2007, American College of Obstetricians and Gynecologists (ACOG), 2009, Asociación Latinoamericana de Diabetes (ALAD), 2008). It is possible that HbA_{1c} will be recommended in the future for postpartum diabetes screening in women with GDM, but studies on this test have not yet been published.

3.1.2 Detection and treatment of cardiovascular risk factors

Every time diabetes screenings are carried out, for detecting hypertension, obesity and dyslipidemias, women with previous GDM are determined for blood pressure, abdominal circumference, body mass index and triglyceride plasma levels, cholesterol, HDL-c and LDL-c. Determination of insulin levels, insulin-sensitivity indices, markers of endothelial activation, fibrinolysis/coagulation and low grade subclinical inflammation, and other specialized tests are optional in the clinical practice and are reserved in most cases, for research purposes. If the presence of any cardiovascular risk factor is confirmed, the corresponding therapeutic measures are prescribed.

3.1.3 Education

Education, initiated during pregnancy, constitutes the basis for GDM management. It is imparted in theoretical-practical sessions individually or in groups, whose content and strategies take into account the socio-economical and cultural characteristics of the enrolled women. At the postpartum stage, it is directed basically to imparting knowledge on future maternal risks and on their off-spring, as well as to the life-style changes that contribute to prevent or retard diabetes development and its co-morbidities. It has been found that knowledge on these topics is limited in women with GDM, but increases after participating in an educational program imparted by specialized health personnel (Rivas et al., 2010a).

3.1.4 Breastfeeding incentive and facilities

As other women, women with GDM must be actively stimulated for exclusively breastfeeding for the longest period during the first year of their child (Metzger et al., 2007). But in this case, it is paramount to contribute in reducing subsequent risks of obesity and glucose tolerance abnormalities. Even though there is currently no definite conclusion on this (Gouveri et al., 2011), many studies show beneficial results of breastfeeding in women with GDM (Kjos et al., 1993; Gunderson et al., 2010).

3.1.5 Appropriate family planning and contraception

In women with GDM postpartum contraception is recommended (Metzger et al., 2007) in order to prevent a future unplanned pregnancy, with a high risk of developing once more GDM and where teratogenic effects of non-diagnosed diabetes may also be present. There is a wide option of contraceptive methods (Kim, 2009; Kim, 2010; Damm et al., 2007) that in general differ little from the ones used by other women. However, it is important to choose a contraceptive method that does not increase maternal risk of glucose intolerance, metabolic syndrome and CVD, as it occurs with barrier methods, the lactation amenorrhea method during the first six months and intrauterine devices (IUD), both copper and

levonorgestrel-releasing IUD, which possess known advantages and limitations. Low-dose combination oral contraceptives, with ethinyl estradiol and a progestin, may also be used, but they are not recommended for women that have other cardiovascular risk factors like hypertension. Even though family history of GDM does not mean contraindication of any method, progestin-only pills should be avoided in women who are breastfeeding, since in a study carried out on Latin-women it was found that it was associated to an increase of diabetes risk, assuming that breastfeeding may be a relatively progestagenic state (Kjos et al., 1998). Neither long-acting progestin methods like depot medroxyprogesterone acetate nor medroxyprogesterone, may be suggested as a first option since they may have major effects on the hydrocarbonated metabolism, as it was proven in Navajo women (Kim et al., 2001). In parous women refraining from another pregnancy, surgical sterilization is a good option, particularly in those delivering by cesarean section, since sterilization may be practiced during surgical procedures.

3.1.6 Oral health measures

It is important that oral health measures proposed to the population in general for prevention of caries and periodontal disease, are rigorously adopted by women with previous GDM, who moreover, should visit at least annually the dentist in order to carry out an early diagnose of these complications when they arise and to apply the required therapeutic measures. The dentist will be on the alert to detect if progression to diabetes has occurred, contributing with this pathology screening (Friedlander et al., 2007).

3.1.7 Life-style changes

Childbearing years constitute one of the stages in the life of a woman more prone to weight gain. Thus, life-style changes make up the building blocks for the prevention of diabetes and other cardiovascular risk factors in women with GDM. Providing preventive care leading to reach and maintain an adequate weight, that include strategies on the aspects shown on Table 3, would result extremely beneficial for the health of this vulnerable population group and also cost-effective (Kapustin, 2008). Even though specific studies on this aspect are scarce and show limitations, it has been found that intensive intervention on life-style changes in women with previous GDM, reduced to a 50% diabetes incidence (Ratner et al., 2008). Undoubtedly, there is a need to study in depth this topic.

- Healthy nutrition
- Physical activity
- Non-smoking
- Low to Moderate alcohol consume
- Adequate stress management

Table 3. Life-style changes in women with previous GDM

3.1.7.1 Healthy nutrition

In general, nutritional recommendations for women with a high risk of developing type 2 diabetes tend to reduce the consumption of processed foods with high content of sugars, salt and trans fats, favoring the consumption of fresh foods like whole grains, legumes, vegetables, fruits, nuts, seeds, low-fat dairy, skinless poultry, and fish to provide omega-3

fatty acids; in other words, foods with low levels of cholesterol and saturated fats but rich in fiber, micronutrients and antioxidants (Melanson, 2008). Daily calorie intake is tailored by nutritionists, according to the characteristics of each woman, so they guarantee weight loss if recommended and at the same time, an adequate nutrition. It is fundamental to provide education on calorie count, food portions, food selection and preparation, reading and interpreting labels, since self-monitoring of intake may help them to incorporate the food plan in their life-styles and adopt these new behavior patterns (Case et al., 2006). Uniform nutritional recommendations in women with a GDM history are needed.

3.1.7.2 Physical activity

Increasing physical activity is paramount in the daily routine of women with previous GDM, if there is no contraindication for this after a thorough medical evaluation. The goal is to reach a program of aerobic exercises like walking, swimming, dancing, bike riding for 30 minutes five or more days a week, beginning gradually from 5-10 minutes daily in sedentary women. Before and after exercising, stretching exercises must be done for 5-10 minutes. If this is complemented with strength training using light weights or elastic bands, weight loss is increased and muscle tone is improved, having a favorable effect on the glucose metabolism (Case et al., 2006).

3.1.7.3 Non-smoking

Quitting smoking is recommended in women with previous GDM (Verier-Mine, 2010), in spite of the lack of studies assessing the effects of tobacco in this group with a high risk of diabetes and cardiovascular disease. Nonetheless, it has been found that smoking increases the risk of diabetes in women, without discerning if they have this family history or not (Rimm et al., 1993).

3.1.7.4 Light to moderate alcohol consumption

Light to moderate alcohol consumption has been found associated with a minor risk of developing type 2 diabetes in middle-aged women and this benefit does not seem to persist when alcohol consumption increases (Wannamethee et al., 2003). It is not known if this result may be generalized to women with previous GDM, but it results sensible to avoid a high level of alcohol consumption due to the possible weight gain and the potential increase of type 2 diabetes risk.

3.1.7.5 Adequate stress management

Learning and the use of periodic tools to allow managing stress adequately may contribute to the goal of keeping healthy women with GDM history. The presence of symptoms of depression or excessive anxiety is an indication for assessment and treatment by specialized Mental Health professionals, according to each case.

3.1.8 Pharmacologic intervention

The use of pharmacologic agents has been explored for preventing or retarding diabetes in women with previous GDM. Studies with troglitazone (Buchanan et al., 2002) and pioglitazone (Xiang et al., 2006b) have been carried out, demonstrating effectiveness in both cases in overweight women. Nonetheless, the former has been discontinued for its hepatotoxic effects, and the use of the latter is limited since its prescription is not authorized for prevention, due to its safety profile regarding future cardiovascular and osteoporosis

disease, and its cost (Verier-Mine, 2010; Kim, 2009: Kim, 2010). When metphormine was used in a study, the risk of type 2 diabetes was half reduced in women with overweight and obesity (Ratner et al., 2008). Therefore, further research will provide more insight for its prescription in clinical practice in combination with a healthy life-style, particularly in obese women with glucose intolerance after a GDM pregnancy.

As shown, an adequate postpartum follow-up program for women with GDM comprises a wide range of health-care, clinical-metabolic, gynecological, nutritional, educational, psycho-social, physical training, and odontological activities, among others, carried out by an interdisciplinary team, in order to prevent or retard progression to diabetes and other cardiovascular risk factors, and if this is not attained, to confirm its diagnose as soon as possible.

Unfortunately worldwide, postpartum follow-ups of women with GDM are low. In the United States during the first postpartum months, FPG measurements were ordered on 60.5% women and only completed by 34% (Dinh et al., 2003). In a long cohort of women with GDM, 42% were not tested for FPG, the test was not ordered in 21% of them and none were tested for OGTT (Dietz et al., 2008). Only 37% were tested for FPG or OGTT with a mean of ~ 14 months of postpartum (Smirmakis et al., 2005). In Canada, it has been shown that physicians do not order postpartum OGTT, in spite of counting on a publication with guidelines based on expert opinions on the subject (Clark et al., 2003). At a Venezuelan hospital, in a follow-up program, a 66.19% OGTT adherence after a postpartum period of 4.04 years $\pm$ 2.68 was met, with only 17.98% attendance to all basic education sessions (Rivas et al., 2010c). Achieving favorable changes in life-styles of women with GDM has resulted even more difficult to attain (Stage et al., 2004; Smith et al., 2005), and progression to diabetes continues increasing.

3.2 Changes in quality of life of the population

Individual approach directed to inform women with GDM on the need of reclassifying their metabolic status after delivery, results insufficient for making possible the prevention of diabetes and other cardiovascular risk factors. The need to reinforce knowledge and motivation in the health care team is evident, as well as the access to health care in this area. Moreover, there is a need for stronger research and confrontation on the social determinants that make difficult for GDM women, adherence to postpartum follow-up and the adoption of healthy life-styles (Hjaltested & Conroy, 2010). Structural measures targeted to the population in general, like the ones shown in Table 4, would undoubtedly result in greater benefit.

- Increasing production, distribution and marketing of fresh foods
- Promoting the creation and use of public transportation, bicycle lanes, walking lanes
- Promoting the creation and use of public sport courts and parks
- Promoting and protecting breastfeeding
- Regulating production, distribution and marketing of processed foods rich in trans fats, saturated fats, salt and refined sugars
- Regulating publicity through communication media of this kind of foods
- Promoting smoke-free environments

Table 4. Changes in quality of life of the population

4. Conclusion

After delivery, women with GDM have a high risk of developing diabetes, metabolic syndrome, CVD and other clinical disorders that imply a decrease in the quality of life and high health-care costs. Thus, over several decades early detection of diabetes and other cardiovascular risk factors has been emphasized. For those women who do not show this, it is very important to apply strategies directed towards primary prevention like healthy life-style changes and possible pharmacological intervention, even though further research on these results is needed. To meet both objectives, it is paramount to carry out, on one hand, life-long postpartum follow-up in women with GDM, and also, to research social determinants that affect compliance to these preventive programs and to put into practice collective measures that create favorable conditions for its adherence.

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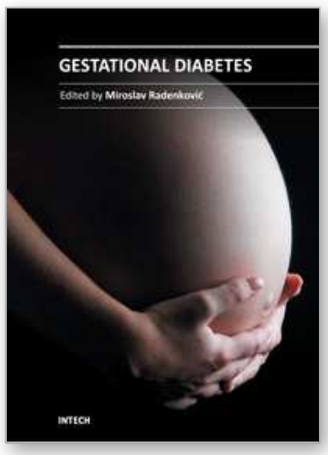

Gestational Diabetes

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Gestational diabetes mellitus is defined as hyperglycemia with onset or first recognition during pregnancy. The incidence of gestational diabetes is still increasing and this pathological condition has strong association with adverse pregnancy outcomes. Since gestational diabetes can have long-term pathological consequences for both mother and the child, it is important that it is promptly recognized and adequately managed. Treatment of gestational diabetes is aimed to maintain euglycemia and it should involve regular glucose monitoring, dietary modifications, life style changes, appropriate physical activity, and when necessary, pharmacotherapy. Adequate glycemic control throughout the pregnancy can notably reduce the occurrence of specific adverse perinatal and maternal outcomes. In a long-term prospect, in order to prevent development of diabetes later in life, as well to avoid associated complications, an adequate education on lifestyle modifications should start in pregnancy and continue postpartum.

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